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(54) Casting method for forming a resin molding

Giessverfahren zur Herstellung von Formteilen aus Kunststoff

Procédé de coulée pour la fabrication d'une pièce en résine synthétique

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Description

BACKGROUND OF THE INVENTION

The present invention relates to a casting method for forming a resin molding, that will be subjected in use to high voltage, by use of a hardenable resin such as an epoxy resin and the like.

Conventionally, to form an insulator by use of a hardenable resin such as an epoxy resin or the like, there has been widely used a casting method.

In recent years, due to the enhancement of a transmission voltage to a super high voltage, there has been an increased need for high stabilization of the quality of an insulating spacer or the like which is used to support a porcelain insulator, a porcelain tube or a connecting conductor within GIS.

Conventionally, when casting a resin molding, a circulatory flow method is known in which a material consisting of a resin mixed with a hardener is cast into a preheated metal mold, the metal mold with the material cast therein is delivered to a heating furnace and the resin is hardened, then the hardened product is released from the metal mold, after release of the hardened product, the metal mold is re-assembled, and the metal mold is again used in said method.

In the above-mentioned circulatory flow method, metal molds corresponding in number to several pieces of products to be cast in one flow are preheated in a pre-heating furnace, a material consisting of a resin mixed with a hardener is cast into these metal molds, and after completion of casting of the material into all metal molds, the metal molds are all delivered at the same time to a heating and hardening furnace.

A hardenable resin for use in the above-mentioned insulating spacer or the like includes a filler such as alumina, silica or the like added thereto and, therefore, in the hardenable resin, before the resin is gelled to a certain viscosity, the filler is inevitably sedimented and is this segregated.

However, in the above-mentioned conventional casting method, even if the same blend or hardener mixed resin is cast into the several metal molds, because the casting time varies for every metal mold and thus the time necessary for delivery to the heating and hardening furnace varies for every metal mold, the filler segregation state inevitably varies between the metal molds. This makes it difficult to completely eliminate variations in quality between the resultant products and thus it is almost impossible to stabilize the quality to a high degree required for the above-mentioned insulating spacer and the like.

A further prior art that is of interest is GB-A-2- 158 003 that discloses a casting method for forming a resin molded workpiece in which a plurality of forming metal molds are circulated through several stations. Stations A to S are disclosed. At a station D a mold with a top part thereon is filled with a flow of liquified material and thereafter the mold is moved to a station E where a

heating curing hardening step is carried out. Thereafter, the mold is moved to a station F where the top part of the mold is lifted off and is circulated back to a station C. At station C said top part is placed on a recirculated empty mold prior to the empty mold being moved via the filling station D and the heat curing station E to the lid removing station F. From the station F the lower part of the mold moves to a station G where the molded work-piece is removed from the mold and the now empty lower part of the mold is then recirculated back to a station B preceding station C. Because there is only one hardening step, namely at station E, the curing time is extremely short since the time cycle for a molding operation is said to be 30 seconds only. This time comprises filling the mold at station D in 10 seconds; allowing 5 seconds to transport the mold now filled with a hot fluid resin to station E (this 5 seconds being counted as a curing time); allowing the mold to rest a station E under heat for 10 seconds, and then moving the mold to the mold disassembly station F where the top part thereof is removed. The time to move from station E to station F is 5 seconds. Thus a total time of 20 seconds will have elapsed between completion of the filling of the mold at station D and its arrival at the mold disassembly station F. According to this prior art, therefore, the result is a curing time of only 20 seconds.

SUMMARY OF THE INVENTION

The present invention aims at eliminating the drawbacks found in the above-mentioned known casting methods.

Accordingly, it is an object of the invention to provide a casting method for forming a resin molding which is able to cast a resin molding according to the assembly line production while eliminating almost completely variations in quality between the products. The invention is as defined in the accompanying claims, Claim 1 of which has been divided into a two-part form based on the assumption that GB-A-2 158 003 is the nearest state of the art.

According to the present invention a method is provided for forming a resin molding in which a plurality of forming metal molds are circulated at a pre-determined time difference comprising:

a step of casting a hardenable resin composition into a preheated forming metal mold at a casting station;

a step of hardening of said cast resin comprising causing each forming metal mold when it has been filled with said resin to be passed to a heating station for hardening the resin in said forming metal mold;

a step of moving a filled mold from said heating station to a resin releasing station where the metal molds are emptied and then returned to said casting station; and in that

at said heating station filled forming metal molds

accumulate in a heating line one after the other, together with a plurality of heating devices, and move along said line towards said resin releasing station such that while one forming mold employed in said step of hardening is being heated by one of said heating devices, another forming mold employed in said step of hardening is being heated by another of said heating devices.

In addition, the forming metal mold may be supported in a vertical direction during all steps.

According to the invention, the period of time from completion of casting of the hardenable resin composition or material into the mold to completion of the heating of the casting in the metal mold for hardening purposes can be made uniform for all of the metal molds. Also, if the hardener mixed resin composition is cast in the same viscosity state into the respective metal molds, then there can be eliminated variations in the filler segregation state between the metal molds to thereby prevent variations in quality between the products almost completely.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 (a) is a section view of an example of a resin molding cast by a casting method according to the invention;

Fig. 1 (b) is a section view of a metal mold for casting the above resin molding;

Fig. 1 (c) is a flow chart when the above resin molding is manufactured according to the invention;

Fig. 2 (a) is a plan view of a manufacturing apparatus to be used in the invention;

Fig. 2 (b) is a time chart which shows the moving states of a metal mold when the resin molding is cast according to the invention by use of the manufacturing apparatus shown in Fig. 2 (a);

Fig. 3 is a perspective view of an embodiment of a heating device to be used in the invention;

Fig. 4 is an explanatory view to show how to cast a material into a metal mold according to the invention;

Fig. 5 (a) is a plan view of a machine in a casting step to be used in the invention;

Fig. 5 (b) is a side view of the above machine; and, Fig. 6 is an explanatory view of a crane shown in Fig. 5.

Fig. 7 is a time chart which shows the other moving states of a metal mold when the resin molding is cast according to the invention by use of the manufacturing apparatus shown in Fig. 2 (a).

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Description will be given below of an embodiment of a casting method according to the invention with reference to the accompanying drawings.

The present invention can be used in casting various kinds of resin moldings, for example, it can be used in casting an insulating spacer as shown in Fig. 1 (a) which is used to support a GIS connecting conductor. In Fig. 1 (a), reference character 11 designates an epoxy resin molding, 12 stands for a conductor connecting metal member which is embedded in the central portion of the epoxy resin molding, and 13 points out a bolt insertion hole metal member which is embedded at a given distance on the outer peripheral side of the epoxy resin molding 11.

As the forming metal mold for the insulation spacer, for example, a metal mold 14, as shown in Fig. 1 (b), can be used which is split vertically and includes a resin casting port 15 at the top end thereof. In Fig. 1 (b), there is shown an assembly state of the metal mold 14 in which the conductor connecting metal member 12, bolt insertion hole metal member 13 and the like are assembled together.

Fig. 1 (c) shows a flow chart when the above-mentioned insulating spacer is manufactured by use of a casting method for forming a resin molding according to the particular embodiment of the invention.

That is, a material is passed sequentially through a measuring step and a mixing step (a step of mixing the material with a hardener) and is then sent to a casting step. And, a metal mold with the material cast therein is then forwarded to a primary hardening step. After completion of the primary hardening, there is a mold releasing step in which the metal mold containing the material is separated into the metal mold and a primarily hardened molding. Then, a conductor connecting metal member or the like (including a bolt insertion hole metal member as well) are assembled together. The emptied metal mold is re-assembled and is then sent back to the casting step. The above-mentioned operations are performed as one circulation or one cycle and, after then, such a circulation flow will be repeated. On the other hand, the primarily hardened molding, which has been released from the metal mold, is then sent to a secondary hardening step, a finishing step and an inspecting step before it is shipped.

Fig. 2 (a) shows a manufacturing apparatus which is used in the present invention. The apparatus, as shown in Fig. 2 (a), comprises devices respectively corresponding to the casting step, primary hardening step, mold releasing step and mold assembling step as well as a device corresponding to the secondary hardening step.

In Fig. 2 (a), reference character 2 designates a material casting station which is used to cast a material or a hardener mixed resin into the metal mold. 3 stands for a heating line which includes a plurality of heating devices, preferably, heating devices of a sandwich type a_1 , a_2 , --- on the side of a main rail 31 with one end portion thereof situated on the material casting station 2. For the sandwich type of heating device, as shown in Fig. 3, there can be used a structure in which two heating plates 32 each containing an electric heater therein

are disposed opposed to each other and are supported by a piston rod 33. In Fig. 2 (a), 34 designates a traverser, 35 stands for an auxiliary rail which is disposed in the other end portion of the main rail 31, and 4 points out a resin releasing and mold assembling station.

The flow of one metal mold in the above production line includes a step of moving an assembled and preheated metal mold to the material casting station 2 by use of the traverser 34 and casting the material into the metal mold, a step of moving the material filled metal mold to a predetermined sandwich type heating device by use of the traverser 34 and holding the metal mold by and between the two heating plates 32 for a predetermined period of time to harden the material (this hardening treatment aims at providing the material with such mechanical strength as allows the material to be removed from the metal mold, and this is a so called primary hardening and this primary hardening will be hereinafter referred to as simply hardening), a step of moving the metal mold, in which the hardening of the material is completed (which will be hereinafter referred to as the hardening completed metal mold) to the resin releasing and mold assembling station 4 by use of the traverser 34, and a step of removing the hardened resin/product from the metal mold and then assembling the resin-released metal mold, and other steps.

Fig. 2 (b) is a time chart which shows the moving states of a metal mold when a resin molding is cast according to the invention by use of the above-mentioned manufacturing apparatus. The transverse axis of the flow chart shows an elapsed time.

In Fig. 2 (b), the movement line of a metal mold A_1 shows that the material is cast for a given time T_3 in the material casting station. After casting of the material, the metal mold is sent into a heating device a_1 and is hardened primarily for a given time T_1 , and after this primary hardening, the metal mold is forwarded to the mold releasing and assembling station where the material is removed from the metal mold and the material released metal mold is then assembled again in a given time T_4 .

The movement lines of metal molds $A_2, \dots, A_n$ respectively show the same meaning as that of the metal mold A_1 , except for a time lag t_1 . The time T_1 necessary for the primary hardening is much longer than the time T_3 necessary for casting of the material and the time T_4 required for the mold releasing and assembling.

In Fig. 2 (b), the time necessary for the metal mold to reach a given heating device after leaving the material casting station, the time for the metal mold to reach the mold releasing and assembling station from a given heating device, and the time necessary for the metal mold to reach the material casting station from the mold releasing and assembling station are ignored here, because they are very much shorter than the times T_1, T_3, T_4 and the like.

To cast a resin according to the present invention, as shown in Fig. 2 (b), after the material is cast into the

metal molds $A_1, A_2, \dots$ at the material casting station, the metal molds $A_1, A_2, \dots$ are then sent into the heating line sequentially with a given time lag t_1 . As can be understood from Fig. 2 (b) as well, a time lag required to send the metals mold from the heating line to the mold releasing and assembling station is also t_1 in order to balance the metal mold movements with each other.

Now, when sending the metal mold A_2 into the heating line, the metal mold A_1 stays still in the heating device a_1 and, therefore, another heating device a_2 is necessary which is used to receive the metal mold A_2 sent into the heating line. And, when sending the metal mold A_3 into the heating line, the metal molds A_1 and A_2 stay still in the heating devices a_1 and a_2 respectively and, therefore, it is necessary for another heating device a_3 to be used to receive the metal mold A_3 . Similarly, when sending the metal mold A_n into the heating line, the metal molds $A_1, \dots, A_{n-1}$ stay still in the heating devices $a_1, \dots, a_{n-1}$, respectively and, therefore, it is necessary for another heating device a_n to receive the metal mold A_n that is sent into the heating line. In other words, the number of metal molds required is n which satisfies an equation, $n-1 < T_1/t_1 < n$ (n is an integer).

When the heating device a_1 completes the primary hardening of the resin contained in the metal mold A_1 , in Fig. 2 (b), as shown by arrows, the metal mold A_1 is forwarded to the mold releasing and assembling station, in which the primarily hardened resin/product is released from the metal mold and the resin released metal mold is then assembled, and the assembled metal mold is further sent to the material casting station in which a new material or resin composition is cast into the metal mold. After that, the metal mold with the material or resin contained therein is again sent into the heating line.

In this case, if the time t ($t = T_3 + T_4$), which is necessary for the metal mold A_1 that is removed from the heating device a_1 to be sent again into the heating line, is shorter than the time lag t_1 ($t_1 \geq T_3 + T_4$), then only the heating device a_1 is empty when the metal mold A_1 is put into the heating line and the metal mold A_2 still stays in the heating device a_2 which is situated so as to be emptied next to the heating device a_1 . Therefore, the metal mold A_1 is sent into the heating device a_1 .

As can be clearly understood from Fig. 2 (b), a time p' (where the metal mold A_1 is put into the heating device a_1 again) is a time which has elapsed during one circulation or one cycle after a time p at which the metal mold A_1 has previously been sent into the heating device a_1 . After this, the cycle will be repeated.

As can be clearly seen from the foregoing description, after the metal mold A_n is put into the heating device a_n , if the time T_1 has elapsed, then the heating device a_n becomes empty for a period of time t . However, if it is necessary to preheat the metal mold after the metal mold has been separated and assembled again, then the preheating treatment can be executed by use of the empty time t . In this instance, if the pre-

heating treatment time is expressed as T_2 , then the following condition must be satisfied: $t_1 \geq T_2 + T_3 + T_4$.

Among the above-mentioned times, the metal mold heating time T_1 may be set according to the sizes of the moldings, the hardening properties of the compositions of the resins and the like and, normally, the standard time T_1 may be in the range of 5 to 6 hours.

In the case of a standard molding, with the mold heating time $T_1 = 5$ hr. 30 min., the time t_1 is set for 1 hr., T_3 is set for 15 min., and T_4 is set for 30 min., respectively; and, if a preheating treatment is necessary, then the time t_1 is set for 1 hr., T_2 is set for 10 min., T_3 is set for 15 min., and T_4 is set for 30 min., respectively.

In the above-mentioned case, the shortest time that can be set as the time lag t_1 is a longer one than that of the time T_3 necessary for casting of the material and the time T_4 necessary for separating and assembling the metal mold. When the time lag t_1 is set for the shortest time, then in Fig. 2 (b), the time t ($t = T_3 + T_4$), which is required for the molded resin to be removed from the metal mold A_1 and to send it back again into the heating line, is longer than the time lag t_1 . However, in this case as well, the metal mold A_1 sent again into the heating line is put into the heating device a_1 similarly to the above-mentioned case.

In the carrying out of the present invention, the above-mentioned time T_1 may vary according to the sizes and shapes of the metal molds, and the hardening properties of the resins.

To cast resin moldings of various kinds and sizes in accordance with the invention, the largest number of heating devices may be set according to the longest time T_1 corresponding to the largest kinds and sizes of resin moldings. That is, when casting the relatively smaller kinds and sizes of resin moldings, the required number of heating devices may be selected and used out of the largest number of heating devices.

In the manufacturing apparatus shown in Fig. 2 (b), a number, T_1/t_1 , of heating devices each of a sandwich type are used for the number, T_1/t_1 , of metal molds.

The manufacturing apparatus used in the invention is not limited to the illustrated one but the number of heating devices of a sandwich type can be set greater than the metal molds to be used so that they can be used as reserves. Also, the heating devices each of a sandwich type can also be arranged on the two sides of the main rail 31.

In the above-mentioned embodiment, the heated state of the resin contained within the metal mold heated by the heating device can be checked by the following mathematical expression 1, where the thermal capacity of the material to be heated is expressed as c , the heat radiation resistance thereof is expressed as r , the quantity of heat generated per unit time by the heating device is expressed as q , and a rise in the temperature of the material to be heated is expressed as ΔT :

[Expression 1]

$$\Delta T = gr (1 - e^{-t/rc}) \quad (1)$$

Therefore, the heated state of the resin can be determined by means of the temperature rise velocity v of the material to be heated that can be obtained from the following expression 2:

[Expression 2]

$$V = \Delta T / \Delta t = g/c \cdot e^{-t/rc} \quad (2)$$

Accordingly, if the thermal capacity c of a molding becomes greater (or smaller) than that of the standard molding due to the difference in shape or in size, then the quantity of heat q generated per unit time by the heating device may be made greater (or smaller) (in a conductive heat radiation system, a conduction current is made greater or smaller) to thereby keep constant the temperature rise velocity expressed by the above expression (2), so that the material or resin composition can be hardened primarily while the metal mold heating time T_3 remains the same as the above-mentioned standard time.

Also, when the resin differs in the compositions thereof, then the quantity of heat q generated per unit time by the heating device may be adjusted to thereby control the metal mold heating temperature or heating time T_3 or control both of them, so that the primary hardening condition can be controlled.

In the above-mentioned embodiment, the idle time of the heating device is a time ($T_3 + T_4$) with respect to the time T_1 during which the heating device is used for heating, and a rate of use $T_1 / (T_1 + T_3 + T_4)$ is 88% in the case of the above-mentioned standard molding, which means that the heating device can be used with a very high efficiency. Thus, in a range which can maintain the rate of use of the heating device at a sufficiently high level, the idle times of the respective heating devices can be adjusted to thereby change the heating times of the respective metal molds, so that moldings differing in the primary hardening times from each other (moldings respectively differing in the resin composition, size or shape from each other) can also be produced in one flow or in one cycle.

According to the invention, it is desirable that a vacuum chamber is used to cast the material into the metal mold. Such material casting state is shown in Fig. 4. In particular, the metal mold 14, which is assembled in the above-mentioned manner, is stored within a vacuum chamber 51 from a door provided on the side portion of the vacuum chamber 51, a lower end nozzle 521 of a mixing kiln 52 disposed just above the vacuum chamber 51 is inserted through a nozzle insertion hole 522 formed at the upper end of the vacuum chamber (a seal ring is mounted onto the nozzle insertion hole so that the nozzle can be inserted through the seal ring in a close contact manner) into an casting port 15 of the

metal mold 14, the pressure in the vacuum chamber 51 is reduced by means of evacuation (evacuation is started automatically if the metal mold enters the vacuum chamber), and under such reduced pressure a valve 523 of the nozzle 521 is opened to thereby cast the material of the mixing kiln 52 into the metal mold.

When the casting of the material into the metal mold is completed, then the evacuation in the vacuum chamber 51 is stopped, the door of the vacuum chamber is opened, in Fig. 2 (a), the material casted metal mold is moved from within the vacuum chamber 51 to the traverser 34, a predetermined sandwich type heating device is selected from a group of sandwich type heating devices a_1 , a_2 , --- in accordance with a control program, the metal mold is moved to and between the two heating plates of the selected sandwich type heating device by computer controlling the traverser 34, and the two heating plates are brought into contact with the metal mold to thereby harden the material primarily. In the primary hardening, preferably, a pressurizing hose is connected with the material casting port of the metal mold so that the material can be hardened while pressurizing the upper surface of the casted material with a pressurizing gas such as pressurizing air or the like.

In the device of Fig. 2 (a), according to the time controlling of the time chart shown in Fig. 2(b), after completion of the primary hardening, the metal mold is allowed to escape from the sandwich type heating device, the metal mold is then transferred through the main rail 31 and auxiliary rail 35 to the resin releasing and mold assembling station 4 by means of computer control of the traverser 34, in which station the material or resin is released from the metal mold and the resin-released metal mold is re-assembled again (that is, the conductor connecting metal member and bolt insertion hole metal member are set), the assembled metal mold is then transferred to the traverser, and the metal mold is then moved into the vacuum chamber 51.

The metal mold, which is assembled after the resin/product is released, remains still at sufficiently high temperatures, that is, remains still in the preheated condition and, therefore, normally, such metal mold requires no preheating treatment. However, when a preheating treatment is necessary, a predetermined sandwich type heating device is selected out of a plurality of sandwich type heating devices a_1 , a_2 --- in accordance with a control program, the metal mold is transferred to and between the two plates of the selected sandwich type heating device by the computer controlling of the traverser to preheat the metal mold, and the preheated metal mold is moved into the vacuum chamber 51.

In Fig. 2 (a), 53 designates a secondary hardening furnace and 54 stands for a conveyor, respectively. That is, the primarily hardened product released from the metal mold is delivered into the secondary hardening furnace 53, in which the primarily hardened product is hardened secondarily. After completion of the secondary hardening treatment, the secondarily hardened product is finished, for example, burred and is then

inspected before it is shipped.

According to the invention, for casting of the material, there can be used such a machine as shown in Fig. 5 (a) (a plan view) and Fig. 5 (b) (a side view), respectively.

In Figs. 5 (a) and (b), 6 designates a turn frame which supports the mixing kiln 52 removably on the arm thereof and then transfers the mixing kiln 52 to a measuring station 61, a stirring station 62, an casting station end 201 and a cleaning station 63 sequentially.

64 designates a mixing resin storage tank into which a predetermined amount of hardenable resin, for example, epoxy resin heated and fused by a resin mixer 65 is supplied by means of a pump (not shown) and also into which a predetermined amount of filler, for example, alumina, silica or the like stored in a filler tank 66 is supplied by means of a pneumatic pipe (not shown) using hot air while heating the filler almost up to the same temperature as the above-mentioned fused resin. The mixing resin storage tank 64 keeps on mixing the fused resin and filler together by use of a stirring blade. 2 stands for the previously described casting station, there is provided the vacuum chamber 51 in the neighborhood of the above-mentioned casting station end 201, and there is provided a crane 67 between the vacuum chamber 51 and casting station end 201.

This crane 67, as shown in Fig. 6, includes a suspension wire 672 which suspends a hatch 671. The hatch 671 is connected to the mixing kiln 52 situated in the casting station end 201 by means of an electromagnetic chuck or the like, the mixing kiln 52 is lifted by pulling up the suspension line 672, and then a crane carrier 673 is travelled horizontally to thereby transfer the mixing kiln 52 to just above the vacuum chamber 51.

To cast the material into the metal mold by use of the machine shown in Figs. 5 and 6, in the measuring station 61, the resin/filler mixture in the mixing resin storage tank 64 corresponding to a piece of resin molding is measured and is then supplied to the mixing kiln 52. Next, the turn frame 6 is rotated 90°, and in the stirring station 62, a predetermined amount of hardener is added from a hardener storage tank 621 to the mixing kiln and is then stirred and mixed together with the resin/filler mixture. Further, the turn frame 6 is rotated 90° and, in the casting station end 201, the hatch 671 secured to end portion of the suspension wire of the crane 67 is connected to the mixing kiln 52, the mixing kiln connected to the hatch is lifted up by pulling up the suspension wire, and the crane carrier 673 is travelled horizontally to thereby position the mixing kiln at a position just above the vacuum chamber 51. The mixing kiln 52 includes an evacuation opening. Thus, just above the vacuum chamber 51, the evacuation opening is automatically coupled to an evacuation hose (not shown), so that the pressure within the mixing kiln can be reduced.

Within the vacuum chamber 51, there has already been stored the above-mentioned preheated metal mold 14 (the preheat temperature of the metal mold 14 is almost equal to the temperature of the fused resin)

and, as shown in Fig. 4, the material stored in the mixing kiln 52 is poured or casted into the metal mold 14.

On completion of casting of the material into the metal mold 14, the evacuation within the vacuum chamber 51 is stopped, the door of the vacuum chamber 51 is opened and the metal mold 14 is transferred to a pre-determined sandwich type heating device for hardening of the material. Also, the emptied mixing kiln 52 is returned back to the casting station by travelling the crane carrier horizontally as well as by operating the crane suspension wire, the hatch is removed from the mixing kiln, the mixing kiln is transferred to the cleaning station by rotating the turn frame 90° and the mixing kiln is cleaned there. On completion of such cleaning the mixing kiln is moved to the measuring station. From now on, the measuring of the resin/filler mixture corresponding to a piece of resin molding, mixing of the hardener, casting of the material into the metal mold, and cleaning are executed repeatedly.

According to the above-mentioned material casting method, there can be made constant the time that extends from addition of the material to the mixing kiln to casting of the resin composition into the metal mold, and there can also be made constant the degree of progress of hardening of the resin composition until the resin composition is cast into the metal mold, so that the hardener mixed resin can be cast into the respective metal molds in the same viscosity state.

In the casting device shown in Fig. 5, although not shown, two mixed resin storage tanks 64 may be provided; so that when changing the compositions of the resin, the compositions of the resin to be changed to can be previously mixed in one mixed resin storage tank; and the other mixed resin storage tank, which is currently in use, can be replaced later with said one mixed resin storage tank.

In addition, the primary hardening condition can be controlled according to the present invention, so that moldings differing in the primary hardening times from each other (moldings respectively differing in the resin composition, size or shape from each other) may be produced by computer controlling in one flow or in one cycle. As shown in one example drawn in Fig. 7, in the case where the metal mold A₃ is much different from other metal molds in the sizes and shapes of the metal molds, the moldings can be produced in one flow or in one cycle by controlling the heating time T₁ of metal mold A₃. That is, since in the present invention a plurality of metal molds and a plurality of heating devices are used, moldings differing in the primary hardening time from each other can be produced by computer controlling in one flow or in one cycle.

In the above-mentioned embodiment, as the heating device, the sandwich type of heating device is used. However, the invention is not limited to this, but other kinds of heating devices can also be used. For example, the metal mold may be arranged such that it contains an electric heater therein, and a conduction power source for the electric heater may be used in place of the sand-

wich type of heating device.

As has been described heretofore, according to the casting method for forming a resin molding in accordance with the invention, a plurality of metal molds can be circulated at a given time difference corresponding to the number of heating devices provided in the order of a step of casting a hardenable resin composition into a preheating metal mold, a step of heating and hardening the cast material (hardenable resin), and a step of releasing the hardened product/material from the metal mold and then re-assembling metal mold. Also, the time that extends from the casting of the material into a mold to the heating of the metal mold sufficient for hardening can be made identical for the respective metal molds and, by casting the hardener mixed resin into the respective metal molds at the same viscosity state, it is possible to eliminate variations in the segregated states of fillers between the metal molds, to completely prevent variations in quality between the products or moldings, and to stabilize the quality of the resin moldings to a high degree.

While the present invention has been described above with respect to preferred embodiments thereof, it should of course be understood that the present invention should not be limited only to these embodiments but various changes or modifications may be made without departure from the scope of the invention as defined by the appended claims.

Claims

1. A casting method for forming a resin molding in which a plurality of forming metal molds (14) are circulated at a pre-determined time difference comprising:

a step of casting a hardenable resin composition into a preheated forming metal mold at a casting station (2);

a step of hardening of said cast resin comprising causing each forming metal mold (14) when it has been filled with said resin to be passed to a heating station for hardening the resin in said forming metal mold;

a step of moving a filled mold from said heating station to a resin releasing station (4) where the metal molds are emptied and then returned to said casting station;

characterized in that

at said heating station filled forming metal molds (a₁ to a_n) accumulate in a heating line (3) one after the other, together with a plurality of heating devices (32), and move along said line towards said resin releasing station (4) such that;

while one forming mold (14) employed in said step of hardening is being heated by one of

said heating devices (32), another forming mold (14) employed in said step of hardening is being heated by another of said heating devices (32).

2. A casting method for forming a resin molding according to Claim 1 wherein said plurality of heating devices (32) are of a sandwich type. 5
3. A casting method for forming a resin molding as in Claim 1 in which a filler packed resin material mixed with a hardener is cast into a preheated forming metal mold at said casting station (2) wherein when the molded material is released from said forming metal mold at said releasing station (4) it is in a primarily hardened state; the released resin molded product being then subjected to a secondary hardening step; said plurality of heating devices (32) being disposed at the side of said heating line (3). 10 15 20
4. A casting method for forming a resin molding according to Claim 1, wherein said forming metal mold (14) is supported in a vertical direction during all steps. 25
5. A casting method for forming a resin molding according to Claim 2, wherein said forming metal mold (14) is supported in a vertical direction during all steps. 30
6. A casting method for forming a resin molding according to Claim 3, wherein said forming metal mold (14) is supported in a vertical direction during all steps. 35
7. A casting method for forming a resin molding according to Claim 1, the period of time extending from completion of casting of said hardenable resin to heating of the metal mold for hardening is made uniform for all of the metal molds. 40
8. A casting method of forming a resin molding according to Claim 2, the period of time extending from completion of casting of said hardenable resin to heating of the metal mold for hardening is made uniform for all of the metal molds. 45
9. A casting method for forming a resin molding according to Claim 3, the period of time extending from completion of casting of said resin material to heating of the metal mold for hardening is made uniform for all of the metal molds. 50
10. A casting method for forming a resin molding according to Claim 1, further including steps of supplying said hardenable resin which comprises the steps of: 55

providing a rotary frame (6) rotatably movable

through a measuring station (61), a hardener stirring station (62), a material casting station (201) and a cleaning station (63) sequentially in this order; and

providing a vessel (52) removably supported by the rotary frame (6),

wherein said measuring station (61) includes means for measuring and casting a main material consisting of a mixture of a resin and a filler into said vessel (52);

wherein said hardener stirring station (62) includes means for casting a predetermined amount of hardener into said main material casting vessel (52) and mixing said main material with said hardener so as to form said hardenable resin, and

wherein said material casting station (2) includes means (67) for removing from said rotary frame (6) said vessel (52) containing therein said hardenable resin, casting said hardenable resin contained in said removed vessel (52) into a forming metal mold (14), and, after completion of said casting, returning said vessel (52) to said rotary frame (6) so that said vessel can be supported by said rotary frame.

Patentansprüche

1. Gießverfahren zum Bilden eines Harzformstückes, in dem eine Vielzahl von formgebenden Metallgießformen (14) in einer vorbestimmten Zeitspanne zirkuliert werden, umfassend:

einen Schritt, in dem bei einer Gießstation (2) eine aushärtbare Harzzusammensetzung in eine vorgeheizte, formgebende Metallgießform (14) gegossen wird;

einen Schritt, in dem das gegossene Harz gehärtet wird, in dem das Führen jeder formgebenden Metallgießform (14) zu einer Heizstation, zum Härten des Harzes in der formgebenden Metallgießform (14), wenn sie mit dem Harz gefüllt worden ist, bewirkt wird;

einen Schritt, in dem eine gefüllte Form von der Heizstation zu einer Harzauslösestation (4) bewegt wird, wo die Metallgießformen geleert werden und dann zu der Gießstation zurückgeführt werden;

dadurch **gekennzeichnet**, daß

sich bei der Heizstation gefüllte Metallgießformen (a₁ bis a_n) in einer Heizstraße (3) zusammen mit einer Vielzahl von Heizeinrichtungen (32) nacheinander sammeln und sich entlang der Straße auf die Harzauslösestation (4) derart zu bewegen, daß, während eine in dem Härteschritt angewendete Gießform (14) durch eine der Heizeinrich-

tungen (32) erhitzt wird,
eine andere in dem Härteschritt angewendete,
formgebende Gießform (14) durch eine andere
der Heizeinrichtungen (32) erhitzt wird.

2. Gießverfahren zum Bilden eines Harzformstückes
nach Anspruch 1, dadurch gekennzeichnet, daß die
Vielzahl von Heizeinrichtungen (32) Sandwich-
Heizeinrichtungen (32) sind.

3. Gießverfahren zum Bilden eines Harzformstückes
nach Anspruch 1, dadurch gekennzeichnet, daß ein
mit Füller versetzter, mit einem Härter gemischter
Harzwerkstoff bei der Gießstation (2) in eine vorge-
heizte, formgebende Metallgießform (14) gegossen
wird, wobei der gegossene Werkstoff in einem im
wesentlichen ausgehärtetem Zustand ist, wenn er
bei der Harzauslösestation (4) aus der formgeben-
den Metallgießform gelöst wird; das ausgelöste
Harz-Gießprodukt dann einem zweiten Härteschritt
unterworfen wird; und die Vielzahl von Heizeinrich-
tungen (32) an der Seite der Heizstraße (3) ange-
ordnet ist.

4. Gießverfahren zum Bilden eines Harzformstückes
nach Anspruch 1, dadurch gekennzeichnet, daß die
formgebende Metallgießform (14) während aller
Schritte in einer vertikalen Richtung gestützt wird.

5. Gießverfahren zum Bilden eines Harzformstückes
nach Anspruch 2, dadurch gekennzeichnet, daß die
formgebende Metallgießform (14) während aller
Schritte in einer vertikalen Richtung gestützt wird.

6. Gießverfahren zum Bilden eines Harzformstückes
nach Anspruch 3, dadurch gekennzeichnet, daß die
formgebende Metallgießform (14) während aller
Schritte in einer vertikalen Richtung gestützt wird.

7. Gießverfahren zum Bilden eines Harzformstückes
nach Anspruch 1, dadurch gekennzeichnet, daß die
sich von der Vervollständigung des Gießens des
aushärtbaren Harzes bis zum Erhitzen der Metall-
gießform zum Härten erstreckende Zeit für alle der
Metallgießformen einheitlich gemacht wird.

8. Gießverfahren zum Bilden eines Harzformstückes
nach Anspruch 2, dadurch gekennzeichnet, daß die
sich von der Vervollständigung des Gießens des
aushärtbaren Harzes bis zum Erhitzen der Metall-
gießform zum Härten erstreckende Zeit für alle der
Metallgießformen einheitlich gemacht wird.

9. Gießverfahren zum Bilden eines Harzformstückes
nach Anspruch 3, dadurch gekennzeichnet, daß die
sich von der Vervollständigung des Gießens des
aushärtbaren Harzes bis zum Erhitzen der Metall-
gießform zum Härten erstreckende Zeit für alle der
Metallgießformen einheitlich gemacht wird.

10. Gießverfahren zum Bilden eines Harzformstückes
nach Anspruch 1, weiterhin Schritte zum Bereitstel-
len des aushärtbaren Harzes umfassend, das fol-
gende Schritte umfaßt:

das Vorsehen eines Drehrahmens (6), drehbar
durch eine Meßstation (61) beweglich, einer
Rührstation (62) für den Härter, einer Werk-
stoffgießstation (201) und einer Reinigungssta-
tion (63), nacheinander in dieser Reihenfolge;
und
das Vorsehen eines durch den Drehrahmen (6)
entfernbar gestützten Gefäßes (52),

wobei die Meßstation (61) eine Einrichtung zum
Messen und Gießen eines Hauptwerkstoffes in das
Gefäß (52) umfaßt,

der aus einer Mischung von einem Harz und einem
Füller besteht;

wobei die Rührstation (62) für den Härter eine Ein-
richtung zum Gießen einer vorbestimmten Menge
von Härter in das Gießgefäß (52) für den Haupt-
werkstoff und das Mischen des Hauptwerkstoffes
mit dem Härter umfaßt, um das aushärtbare Harz
zu bilden, und

wobei die Werkstoffgießstation (2) eine Einrichtung
(67) zum Entfernen des Gefäßes (52), das darin
das aushärtbare Harz enthält, von dem Drehrah-
men (6), das Gießen des in dem entfernten Gefäß
(52) enthaltenen, aushärtbaren Harzes in eine
formgebende Metallgießform (14), und, nach Ver-
vollständigung des Gießens, das Zurückführen des
Gefäßes (52) zu dem Drehrahmen (6) umfaßt, so
daß das Gefäß durch den Drehrahmen gestützt
werden kann.

Revendications

1. Procédé de coulée pour former un produit moulé en
résine, dans lequel plusieurs moules de formage en
métal (14) sont mis en circulation avec un décalage
temporel prédéterminé, comprenant:

une étape de coulée d'une composition de
résine durcissable dans un moule de formage
en métal préchauffé, dans un poste de coulée
(2);

une étape de durcissement de ladite résine
coulée, comprenant le transfert, lorsqu'il a été
rempli de ladite résine, de chaque moule de
formage en métal (14) à un poste de chauffage,
pour durcir la résine dans ledit moule de for-
mage en métal;

une étape de déplacement d'un moule rempli
depuis ledit poste de chauffage jusqu'à un
poste (4) de démoulage de résine, dans lequel
les moules en métal sont vidés et ensuite ren-
voyés audit poste de coulée;

caractérisé en ce que

dans ledit poste de chauffage, les moules de formage en métal remplis (a_1 à a_n) s'accumulent l'un après l'autre dans une ligne de chauffage (3), en même temps que plusieurs dispositifs de chauffage (32), et se déplacent le long de ladite ligne, vers ledit poste (4) de démoulage de résine, de telle sorte que:

pendant qu'un moule de formage (14) utilisé dans ladite étape de durcissement est chauffé par l'un desdits dispositifs de chauffage (32), un autre moule de formage (14) utilisé dans ladite étape de durcissement est chauffé par un autre desdits dispositifs de chauffage (32).

2. Procédé de coulée en vue de former un produit moulé en résine selon la revendication 1, dans lequel lesdits plusieurs dispositifs de chauffage (32) sont de type en sandwich. 20
3. Procédé de coulée en vue de former un produit moulé en résine selon la revendication 1, dans lequel un matériau de résine additionné d'une charge, mélangé à un durcisseur, est coulé dans un moule de formage en métal préchauffé dans ledit poste de coulée (2), dans lequel, lorsque le matériau moulé est démoulé dudit moule de formage en métal dans ledit poste (4) de démoulage, il se trouve dans un état de durcissement primaire; le produit moulé en résine, démoulé, étant alors soumis à une étape de durcissement secondaire; lesdits plusieurs dispositifs de chauffage (32) étant disposés sur le côté de ladite ligne de chauffage (3). 25 30 35
4. Procédé de coulée en vue de former un produit moulé en résine selon la revendication 1, dans lequel ledit moule de formage en métal (14) est soutenu dans une direction verticale pendant toutes les étapes. 40
5. Procédé de coulée en vue de former un produit moulé en résine selon la revendication 2, dans lequel ledit moule de formage en métal (14) est soutenu dans une direction verticale pendant toutes les étapes. 45
6. Procédé de coulée en vue de former un produit moulé en résine selon la revendication 3, dans lequel ledit moule de formage en métal (14) est soutenu dans une direction verticale pendant toutes les étapes. 50
7. Procédé de coulée en vue de former un produit moulé en résine selon la revendication 1, dans lequel la durée qui s'écoule entre la fin de la coulée de ladite résine durcissable et le chauffage du moule en métal en vue du durcissement est rendue

uniforme pour tous les moules en métal.

8. Procédé de coulée en vue de former un produit moulé en résine selon la revendication 2, dans lequel la durée qui s'écoule entre la fin de la coulée de ladite résine durcissable et le chauffage du moule en métal en vue du durcissement est rendue uniforme pour tous les moules en métal. 5
9. Procédé de coulée en vue de former un produit moulé en résine selon la revendication 3, la durée qui s'écoule entre la fin de la coulée de ladite résine durcissable et le chauffage du moule en métal en vue du durcissement est rendue uniforme pour tous les moules en métal. 10
10. Procédé de coulée en vue de former un produit moulé en résine selon la revendication 1, comprenant en outre des étapes consistant à fournir ladite résine durcissable, qui comprend les étapes consistant à:
 - prévoir un bâti rotatif (6) qui peut être déplacé par rotation en passant par un poste de mesure (61), un poste de brassage de durcisseur (62), un poste de coulée de matériau (201) et un poste de nettoyage (63), successivement et dans cet ordre; et
 - prévoir une cuve (52) soutenue de manière libérable par le bâti rotatif (6),
 - dans lequel ledit poste de mesure (61) comprend des moyens pour mesurer et couler dans ledit récipient (52) un matériau principal constitué d'un mélange d'une résine et d'une charge;
 - dans lequel ledit poste de brassage du durcisseur (62) comprend des moyens pour couler une quantité prédéterminée de durcisseur dans ledit récipient (52) de coulée du matériau principal et mélanger ledit matériau principal audit durcisseur de manière à former ladite résine durcissable, et
 - dans lequel ledit poste de coulée de matériau (2) comprend des moyens (67) pour enlever dudit bâti rotatif (6) ledit récipient (52) contenant ladite résine durcissable, couler ladite résine durcissable contenue dans ledit récipient (52) retiré dans un moule de formage en métal (14) et, après achèvement de ladite coulée, renvoyer ledit récipient (52) vers ledit bâti rotatif (6) de telle sorte que ledit récipient puisse être porté par ledit bâti rotatif.

Fig. 1(a) Fig. 1(b)

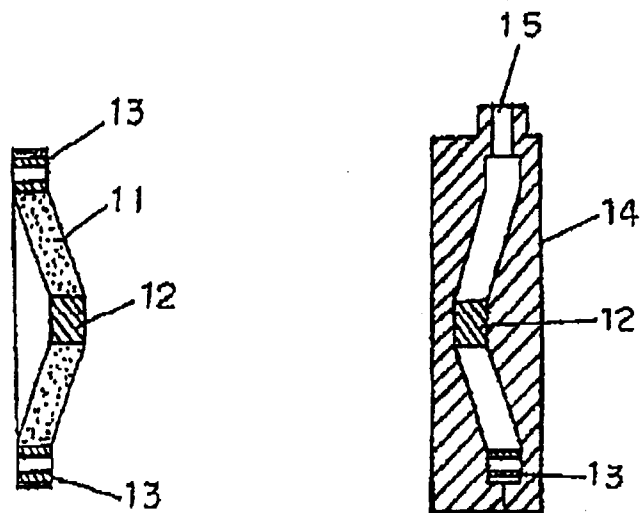


Fig. 1(c)

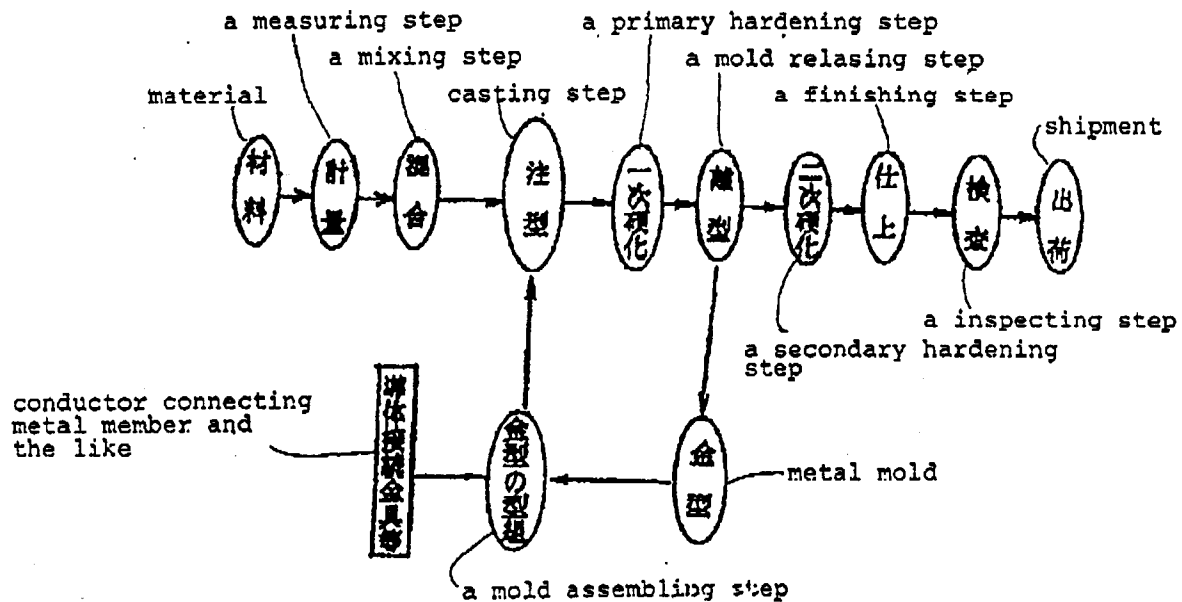


Fig. 2 (a)

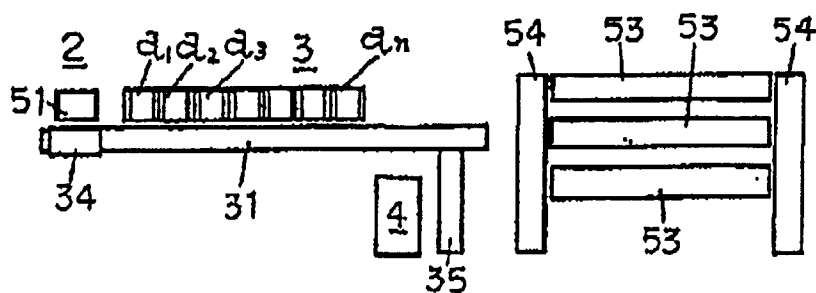


Fig. 2 (b)

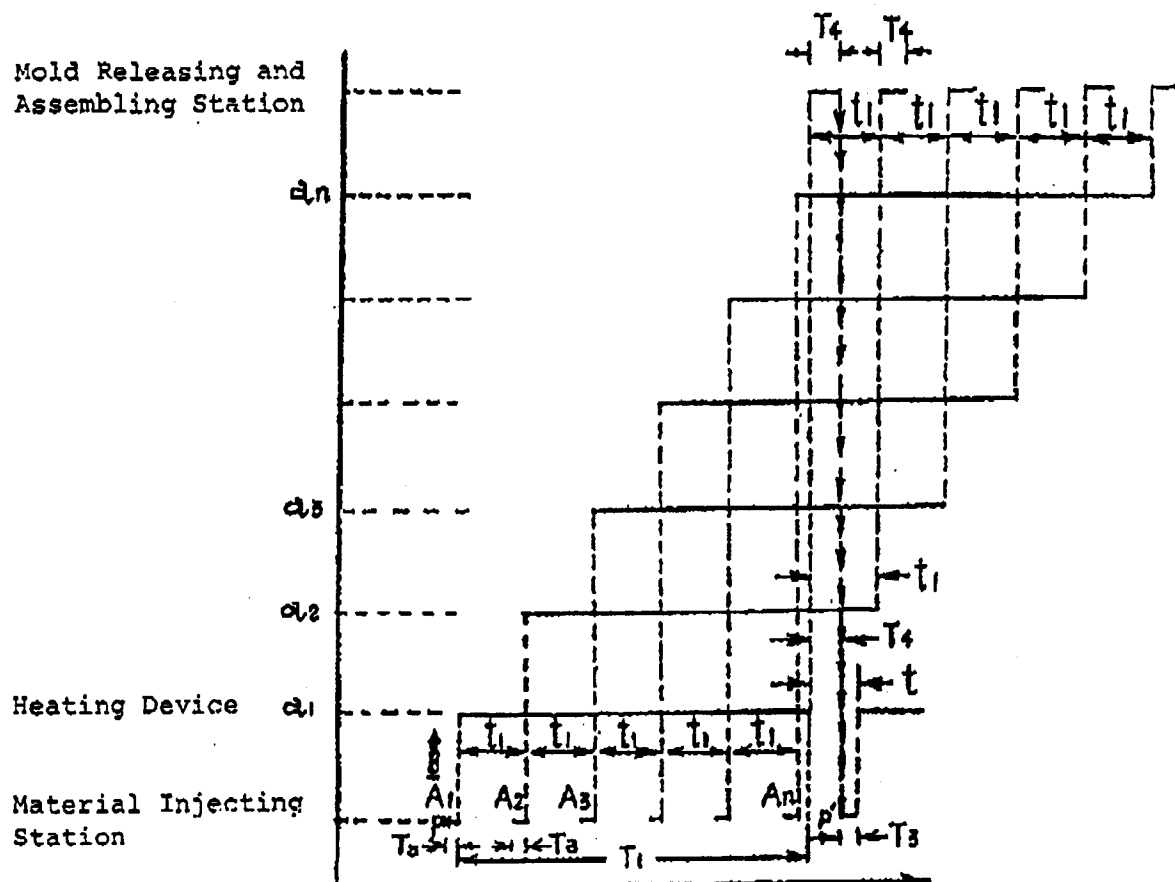


Fig. 3

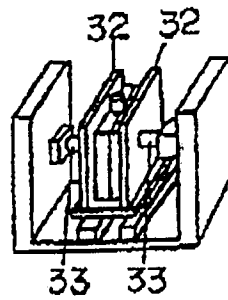


Fig. 4

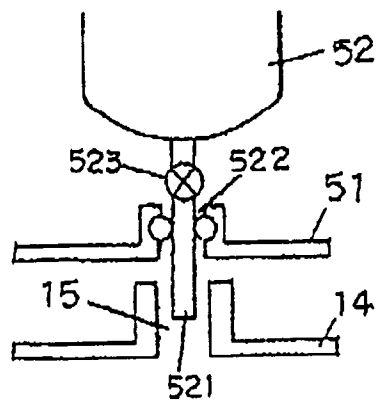


Fig. 5 (a)

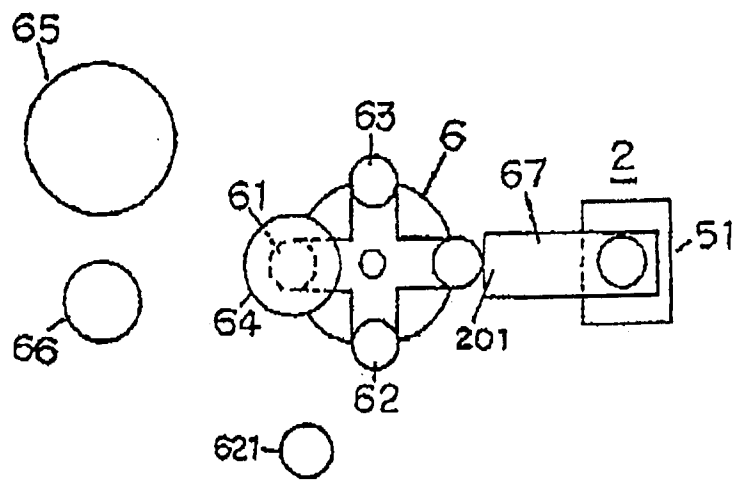


Fig. 5 (b)

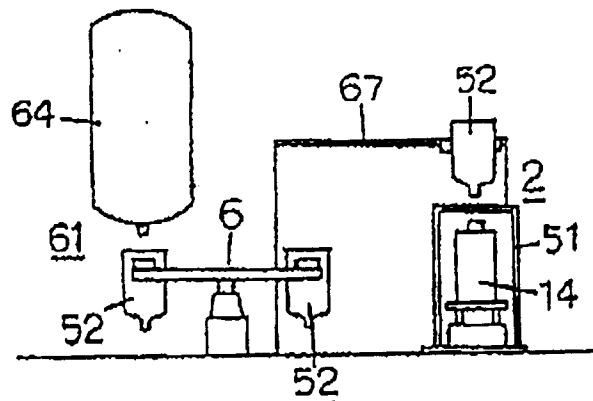


Fig. 6

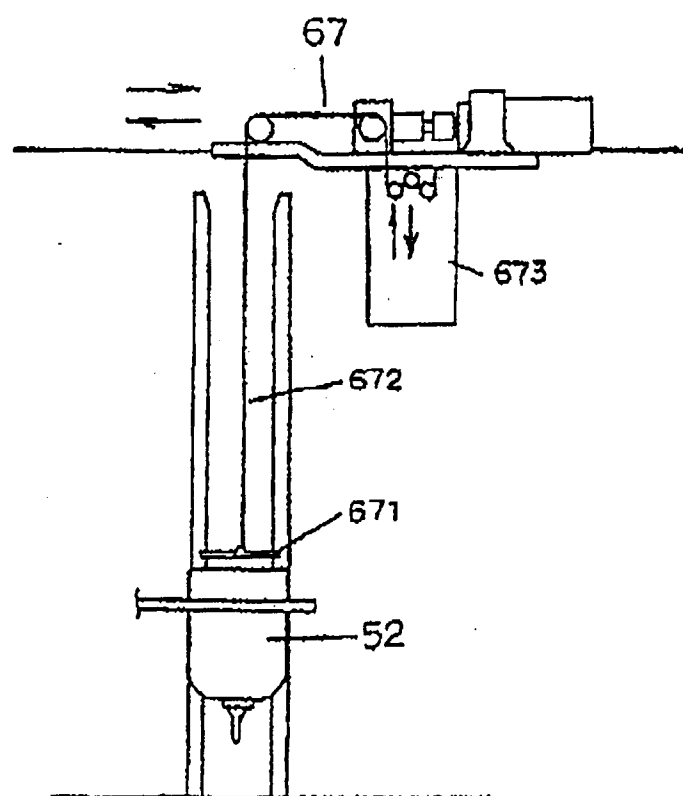


Fig. 7

